June 2004 NC Weather Review

Overview

Numerous thunderstorms in June brought significant rainfall to a large portion of North Carolina breaking a recent trend of dry weather. A significant portion of the state received between 4 and 7 inches of rain. These above normal totals broke a string of 8 consecutive months of below normal rainfall at many locations. The greatest monthly rainfall amounts, 8 to 10 inches, fell over portions of western North Carolina. Several stations reported amounts in excess of 8 inches including Gastonia (Gaston County), 10.86 inches; Laurel Springs (Alleghany County), 10.25 inches; Dobson (Surry County), 8.21 inches; and Charlotte (Mecklenburg County), 8.20 inches.

While many locations in North Carolina observed above normal rainfall for the month of June, there were still areas that were relatively dry. Some locations observed rainfall totals less than 3 inches. The driest areas were over portions of the interior Piedmont where Winston-Salem (Forsyth County) reported only 2.17 inches of rain; Greensboro (Guilford County) reported 2.36 inches, and Apex (Wake County) reported 2.61 inches. The total at Greensboro was 1.17 inches below normal for June, allowing their string of consecutive months with sub normal rainfall to reach 9. The state's Southern Coastal Area was also dry in June where Wilmington (New Hanover County) reported only 2.66 inches (2.70 inches below normal). Figure 1 highlights the observed rainfall versus normal for selected stations across North Carolina during June of 2004. Note that five of the selected seven locations had above normal rainfall for the month.

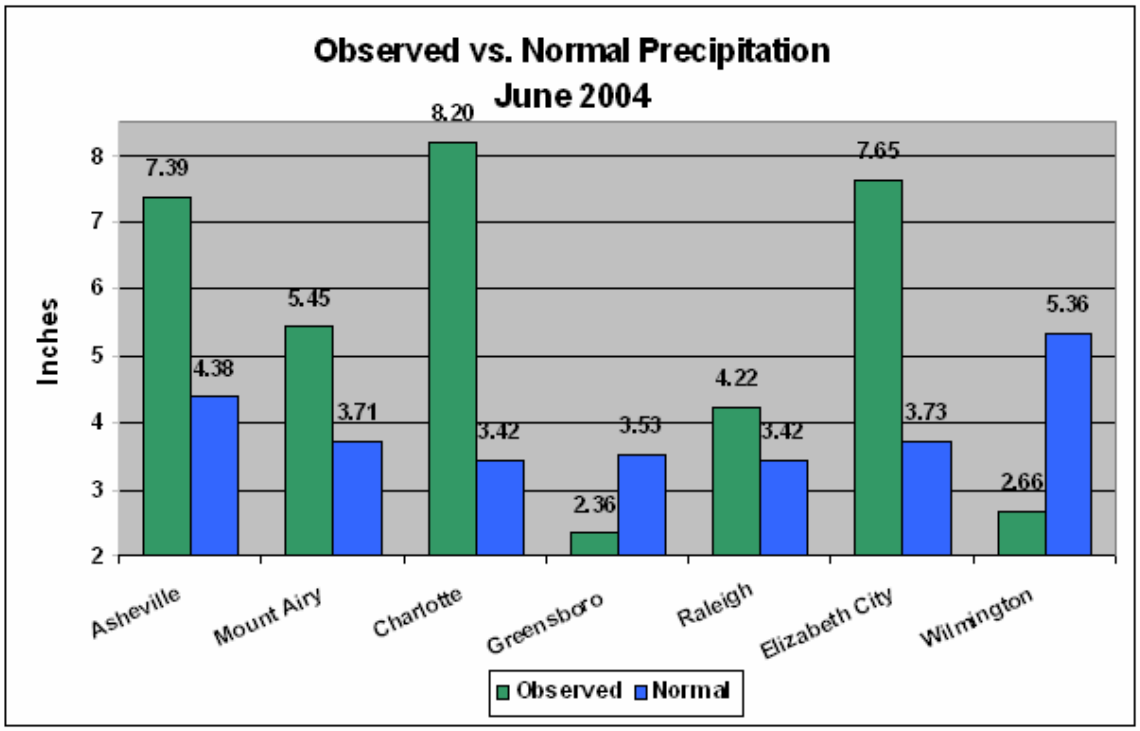

Figure 1 Monthly precipitation reports vs. normal rainfall for June 2004 at selected locations across North Carolina.

Temperatures during June 2004 generally averaged between 0.5 to 1.5 degrees above normal across the state. The Outer Banks were an exception with average temperatures ranging from 2 to 3 degrees above normal. Unlike May of 2004, there were no prolonged periods of hot weather during June. However, there were several days in which the temperatures reached the mid 90s. These hot days were short-lived due to a meteorological pattern that supported frequent frontal passages. On several occasions following the passage of a cold front, temperatures from one day to the next were frequently 10 to 20 degrees cooler. The fronts also had a tendency to stall just to the south of the state, and then within 24 to 48 hours move northward across North Carolina as warm fronts. The back and forth movement of these frontal boundaries aided in the formation of clouds and thunderstorms. This in turn moderated the daytime temperatures. Figures 2 and 3 highlight the daily temperatures at both Raleigh-Durham and Greensboro. Note that there were four distinctive short-lived warm periods where cooling quickly followed due to frontal passages.

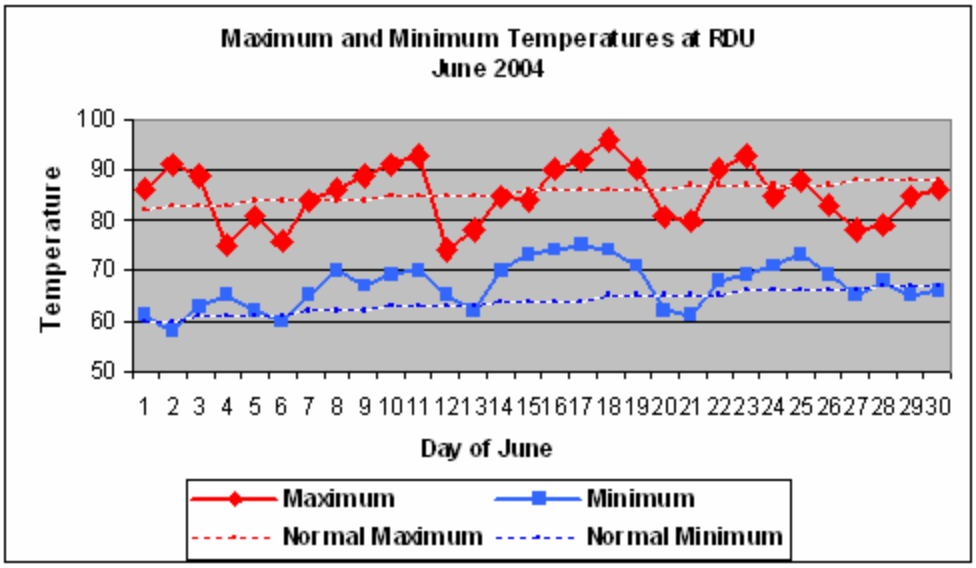

Figure 2 Daily maximum and minimum temperatures observed in June 2004 at Raleigh (RDU).

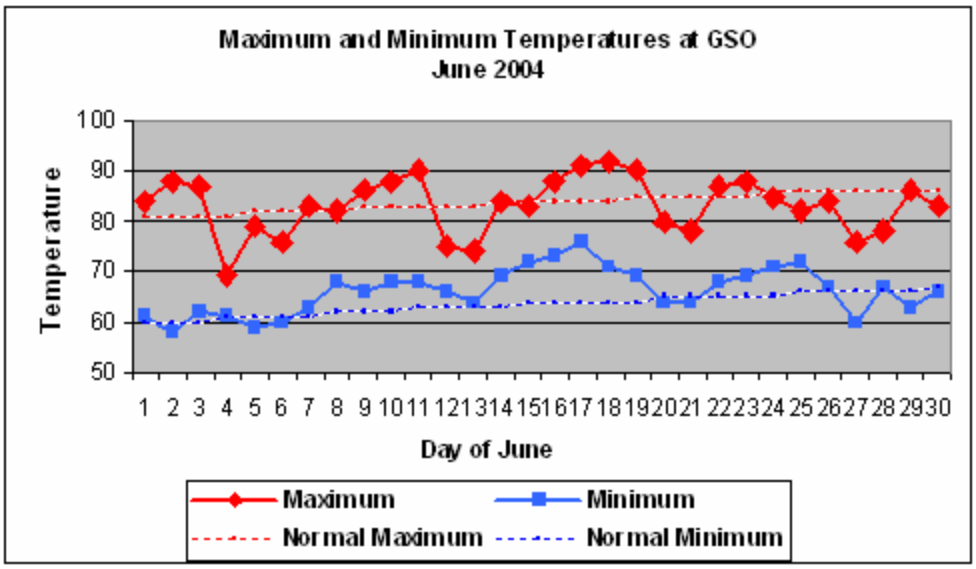

Figure 3 Daily maximum and minimum temperatures observed in June 2004 at Greensboro (GSO).

Details

Temperatures

Temperatures during June 2004 were relatively mild compared to the record warmth of May 2004. There were no record high or record low temperatures recorded at the official reporting stations in June. There were a few hot spells but the heat only lasted a few days before the temperatures cooled due to clouds and thunderstorms. The most significant hot spell occurred between June 17th and June 19th. This hot spell developed in response to a large upper level subtropical high pressure system that briefly strengthened over the southeastern states. Figure 4 depicts the high pressure system at the 500 MB level as analyzed during the early morning on June 18, 2004. The hottest temperatures of the month were recorded at various stations on June 18th or 19th. Some selected stations and their hottest temperatures recorded during June 2004 included: Raleigh-Durham, 96 degrees (on the 18th); Lumberton, 95 degrees (18th, and 19th); Wilmington, 95 degrees (18th); Elizabeth City, 95 degrees (18th); New Bern, 93 degrees (18th); Cape Hatteras, 88 degrees (19th); and Asheville, 87 degrees (11th).

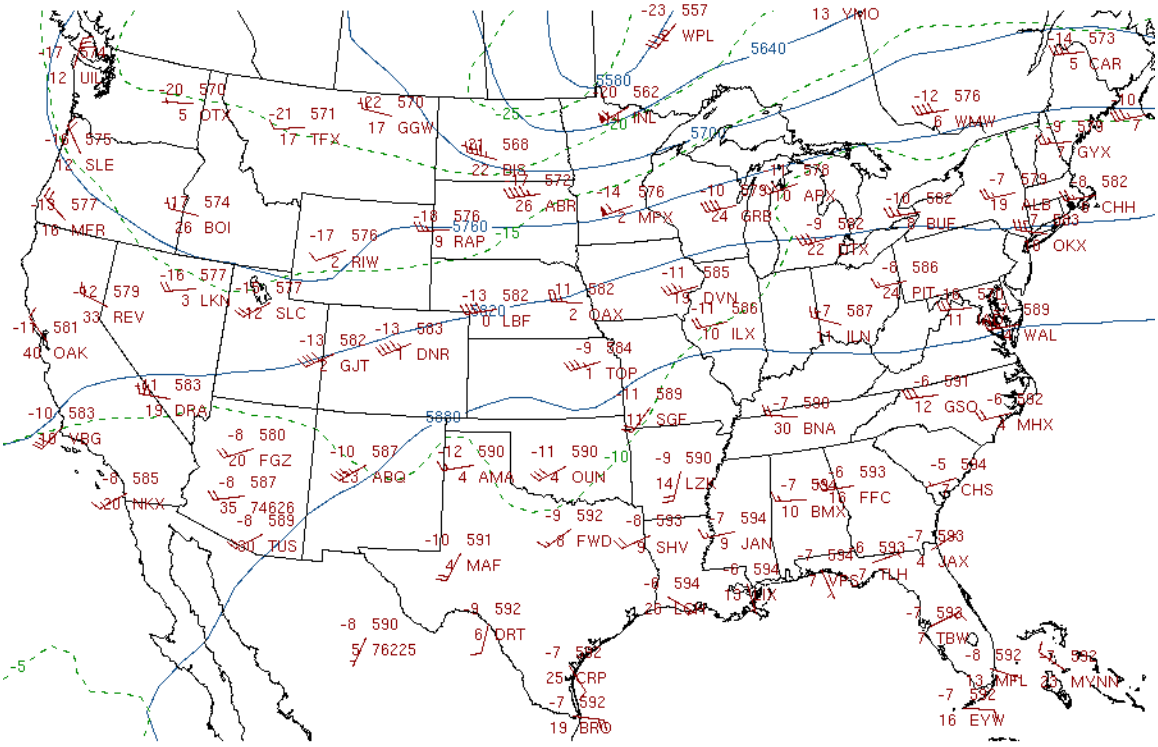

Figure 4 Analyzed upper air map from 12Z (800 AM EDT) June 18, 2004

The upper level ridge of high pressure quickly shifted east by the 20th and persistently remained well off the Southeast coast during the last week of June. The eastward movement of the subtropical high allowed for cold fronts to frequently enter the state, bringing showers and thunderstorms and preventing the return of hot weather.

The frequent frontal passages and precipitation in June kept persistent excessive heat away from the state. However, the monthly temperature still averaged between 0.5 to 3 degrees above normal. These warmer than normal monthly temperatures can be essentially attributed to warm night time temperatures. The temperature readings at night averaged 2 to 4 degrees above normal at many stations including Raleigh-Durham, and Greensboro which averaged 2.7 and 3.3 degrees respectively above normal. By comparison, the daytime temperatures averaged slightly below normal at most stations including Raleigh-Durham (0.2 degrees below normal) and Greensboro (0.6 degrees below normal). Figures 2 and 3 highlight the daily maximum and minimum temperatures versus normal at both Greensboro and Raleigh. Note the significant number of nights where the low temperatures were "well above normal" (5 to 10 degrees).

The unusually warm nighttime temperatures were likely a result of increased moisture and cloud cover that occurred during the month. A night time cloud cover acts as a blanket above the surface of the earth trapping the heat of the day near the ground. This process keeps the night time surface temperatures warmer than what would be expected under clear skies. Thunderstorms also aid in this process of nighttime cloudiness by wetting the ground and allowing for increased humidity, fog and low cloud development. Clouds were so extensive at times that they persisted well into the afternoon hours. These clouds kept the daytime temperatures from attaining their maximum potential as compared to a day when more sunshine is observed.

Precipitation

With the frequent frontal passages, the June 2004 rainfall totals were generally above normal across the state. Figure 5 depicts the estimated rainfall totals for North Carolina for June 2004. The map is based on actual rainfall reports from National Weather Service Cooperative Observers or Official Measuring Sites and Doppler radar estimates. The heaviest monthly rainfall totals, between 8 and 10 inches, fell in a region that extended from the Mountains eastward across the southern Piedmont. Another maximum of rainfall, between 6 to 9 inches, fell from the eastern Sandhills region, eastward across the central Coastal Plain and into the central and northern Coastal Area.

The thunderstorm produced rains in June were far from equally distributed. Despite many locations receiving above normal monthly rainfall in June, there were scattered areas across the state that remained fairly dry. These locations averaged around 2 to 3 inches of rain, which represents only between 50 and 75 percent of normal. The unusually dry locations included much of the northwest Piedmont, large areas of the northeast Piedmont, the entire southern Coastal Area and portions of the eastern Sandhills. The cities and towns that endured a dry month included: Winston-Salem, Kernersville, Greensboro, Chapel Hill, Raleigh (NCSU), Southern Pines, Whiteville, Elizabethtown, Wilmington and Atlantic Beach.

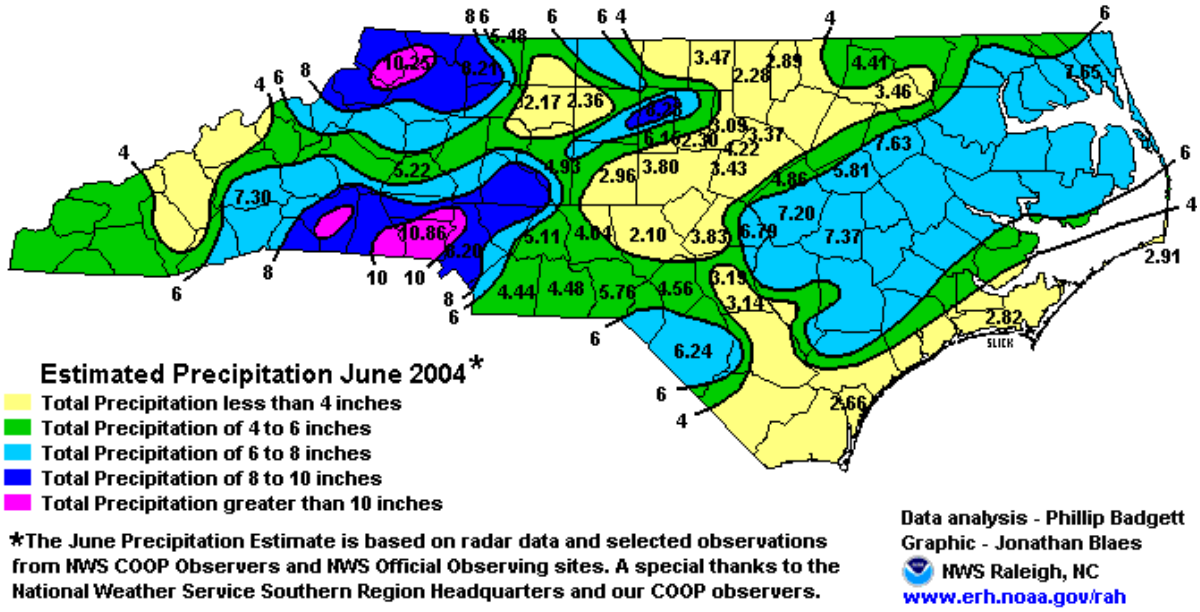

Figure 5 Estimated rainfall totals for June 2004

Storm Scale Considerations

Even within areas that received the heaviest rainfall during June, the amounts varied greatly within county boundaries and even within some towns themselves. Because of the scattered and localized nature of thunderstorms, the large variability of precipitation is typical during the summer months across North Carolina. Figure 6 is a comparison of selected daily rainfall amounts at two locations in the Foothills region of northwestern North Carolina. Although these two sites are only 10 miles apart in Surry County, there were several days in which one site had very heavy rain in thunderstorms, while the other location had very little or no precipitation. For the month, the two station's rainfall totals differed by 3 inches. Dobson recorded 8.21 inches while Mount Airy received only 5.45 inches.

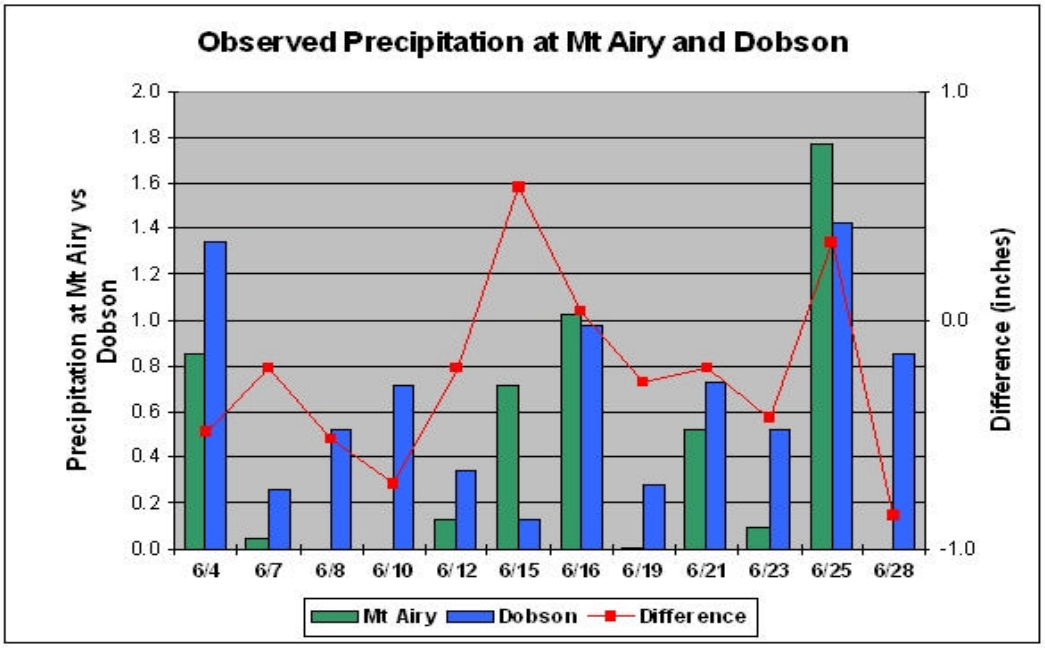

Figure 6 Selected daily rainfall amounts at Mount Airy and Dobson in Surry County.

Figure 7 is a comparison of selected daily rainfall totals at two sites in Wake County in the eastern Piedmont. The sites are Raleigh at North Carolina State University (NCSU) and the Raleigh-Durham Airport (RDU). The Raleigh-Durham Airport (RDU) site recorded 4.22 inches of rain during June (0.80 inches above normal), while the NCSU site recorded 3.45 inches of precipitation for the month. While only 10 miles apart, RDU recorded much of its rainfall during the first half of the month and NCSU had its heaviest thunderstorm rains during the last half of the month. Most striking was the fact that Raleigh (NCSU) recorded less than a half inch of rainfall for a 20 day stretch between June 5th and June 25th while many surroundings areas had several thunderstorms including RDU.

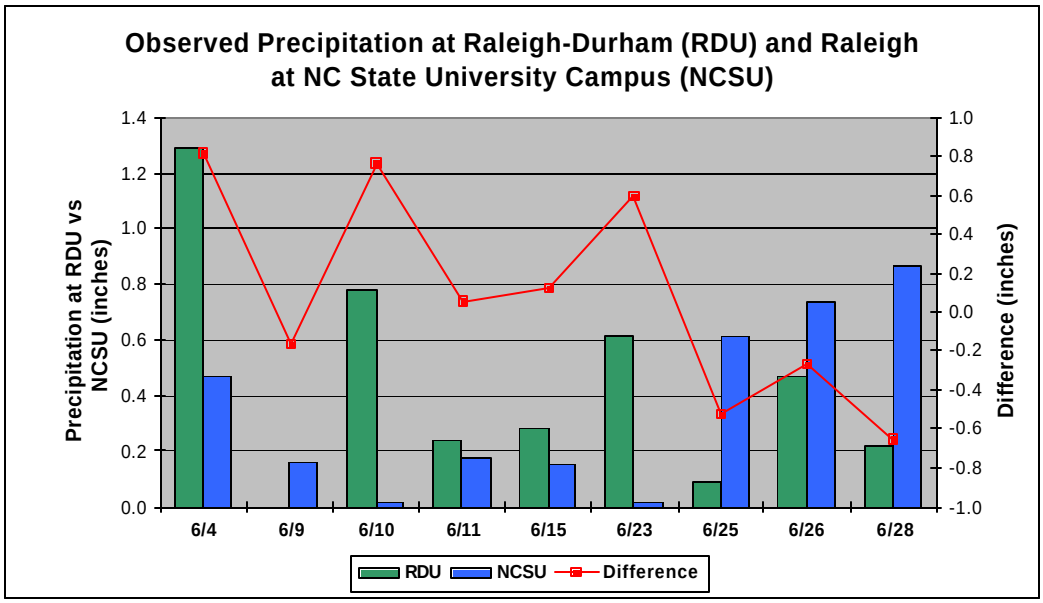

Figure 7 Selected daily rainfall amounts at Raleigh-Durham (RDU) and Raleigh (NCSU).

Figure 8 shows the 24 hour precipitation estimate from the Raleigh Doppler Radar ending at 800 A.M. on June 29, 2004. The color bar at the top left of the figure depicts the estimated 24 hour precipitation amounts in inches (yellow, mustard, and orange colors are precipitation amounts of 2 to 4 inches, deep blue 4 to 6 inches, red 6 to 8 inches, and pink 8 inches or more). Scattered thunderstorms on the 28th dropped locally heavy rain in western Surry County where radar estimates reached over 4 inches just west of Dobson. The Dobson site received 0.85 of an inch while Mount Airy received none. In Wake County, heavy rain fell from thunderstorms over Raleigh (0.84 inches at NCSU) while only 0.24 inches fell at RDU in western Wake County. Of note is the wide distribution of rainfall amounts not only over the region, but from one county to the next.

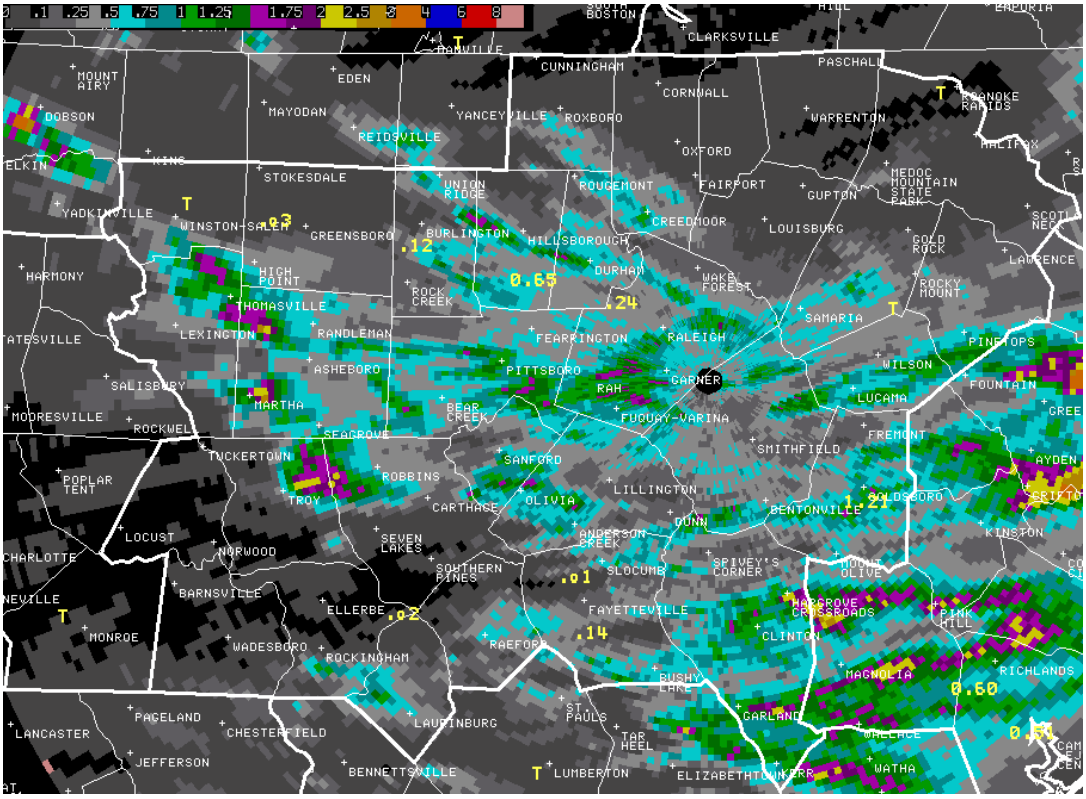

Figure 8 Raleigh Doppler Radar Precipitation Estimates from June 28, 2004.

The factors accounting for the variability of rainfall associated with thunderstorms across time and space are many. On a given summer day, the observance of heavy rain in close proximity to a location receiving little or none is not uncommon. However there were at least two factors present during the month of June that would favor large storm scale differences in rainfall over short distances and from one day to the next.

During the month of June, wind speeds in the mid and upper levels of the atmosphere were generally light (10 mph or less). This resulted in slow moving thunderstorms that tended to drop large amounts of rain over small areas before dissipating. The frequent back and forth movement of weak surface fronts seen in North Carolina during June produced a favored location for thunderstorm development. Convective storms tend to develop along these shallow boundaries where the low level winds converge forcing the moist and unstable air upward where eventual cooling from rising air leads to clouds and precipitation. While the storm scale rainfall pattern is always influenced by the merger of individual storms and the development of new storms associated with the cool downdrafts generated by earlier storms, it was the combination of light winds through a deep layer of the atmosphere and the frequent presence of shallow frontal boundaries that in large part defined the rainfall distribution observed in North Carolina during the month of June.

Severe Weather and Tornado Reports in June 2004

There were several severe weather events that affected central North Carolina during June. Two of the events have been summarized and documented at the web sites below.

June 04, 2004 severe thunderstorm and tornado event…
http://www2.ncsu.edu/eos/service/pams/meas/sco/research/nws/cases/20040604/

June 23, 2004 severe thunderstorm event…
http://www2.ncsu.edu/eos/service/pams/meas/sco/research/nws/cases/20040623/

Current, Semi-Annual and Annual Precipitation Trends

The string of 8 consecutive months of below normal monthly precipitation ended at most North Carolina locations during June. However, dry conditions persisted at a few sites, including Greensboro. June marked the 9th consecutive month of below normal rainfall at Greensboro. Other cities and towns that continued to have below normal rainfall through June included: Winston-Salem, Chapel Hill, and Wilmington.

Precipitation amounts at Greensboro continued to be drier than normal for the most recent 6-month period (January 2004 through June 2004). The string of 9 consecutive dry months dates back to October 2003. During this 9 month period (October 2003 through June 2004), the rainfall deficit at Greensboro totaled 12.89 inches. In the 6-month period prior to the beginning of this dry streak (April through September 2003); there was a rainfall surplus of 19.01 inches at Greensboro. In the past 12 months (July 2003 through June 2004), Greensboro has seen a net precipitation deficit of only 0.58 inches.

At Raleigh (RDU), June 2004 was the first month in 2004 with above normal rainfall. So far in 2004, the precipitation deficit at Raleigh was running at 1.49 inches. In the past 9 months, only December 2003 and June 2004 have had above normal precipitation. During this 9 month period (October 2003 through June 2004), the precipitation deficit at RDU totaled 5.52 inches. In the 6-month period (April 2003 through September 2003) leading up to the dry spell, Raleigh had a net rainfall surplus of 8.01 inches. During the past 12 months (July 2003 through June 2004), Raleigh has seen a net deficit of only 0.41 inches of precipitation.

Semi-annual and annual precipitation trends at Raleigh and Greensboro are highlighted in figures 9 and Figure 10 respectively.

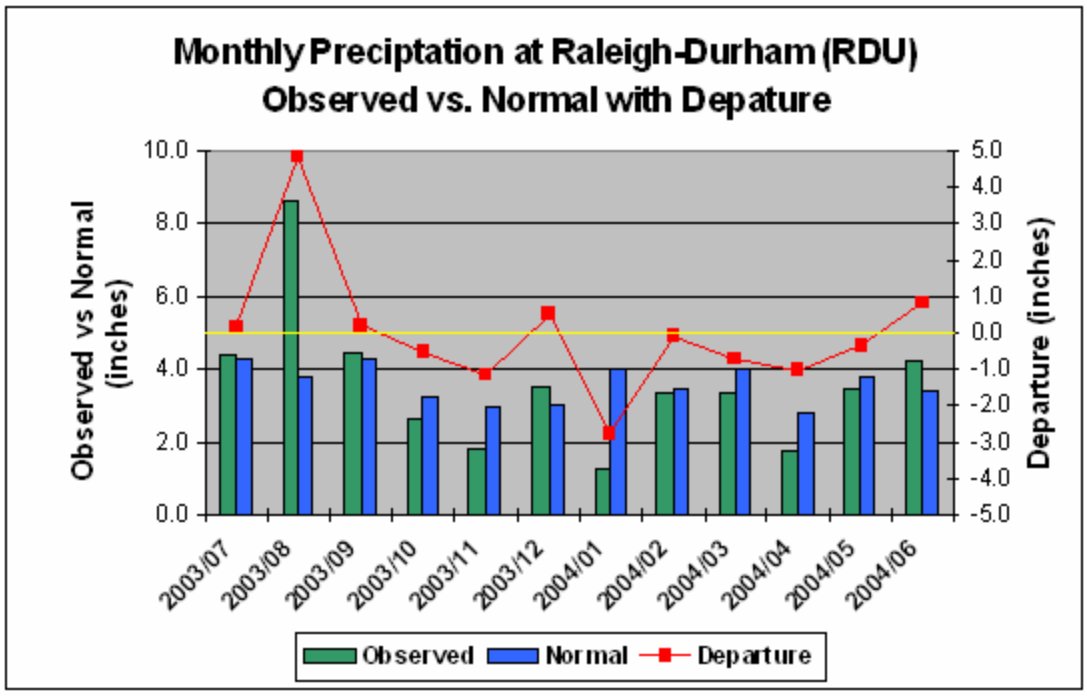

Figure 9 Chart depicting the semi-annual and annual precipitation trends at Raleigh-Durham (RDU).

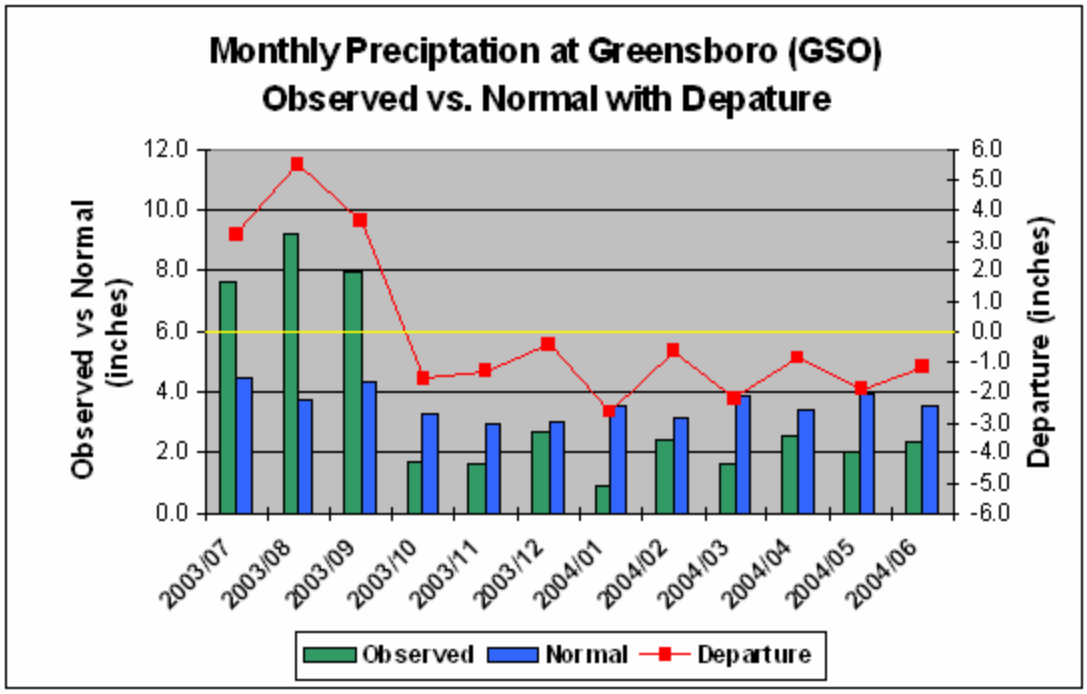

Figure 10 Chart depicting the semi-annual and annual precipitation trends at Greensboro (GSO).

The above normal rainfall amounts throughout much of the state in June helped ease the short-term drought threat. In addition, the tremendous surplus of precipitation prior to October 2003 offset the general dry period of the past 6 months. Currently, there is no long-term drought or ground water shortage in North Carolina. As indicated by the Drought Monitor (Figure 11), the short term drought that was affecting much of southwestern North Carolina as of May 31, 2004 has now eased.

The outlook for July and August of 2004 from the Climate Prediction Center is for a continual easing of the residual dry conditions across portions of the Piedmont, eastern Sandhills, and southern Coastal Area.

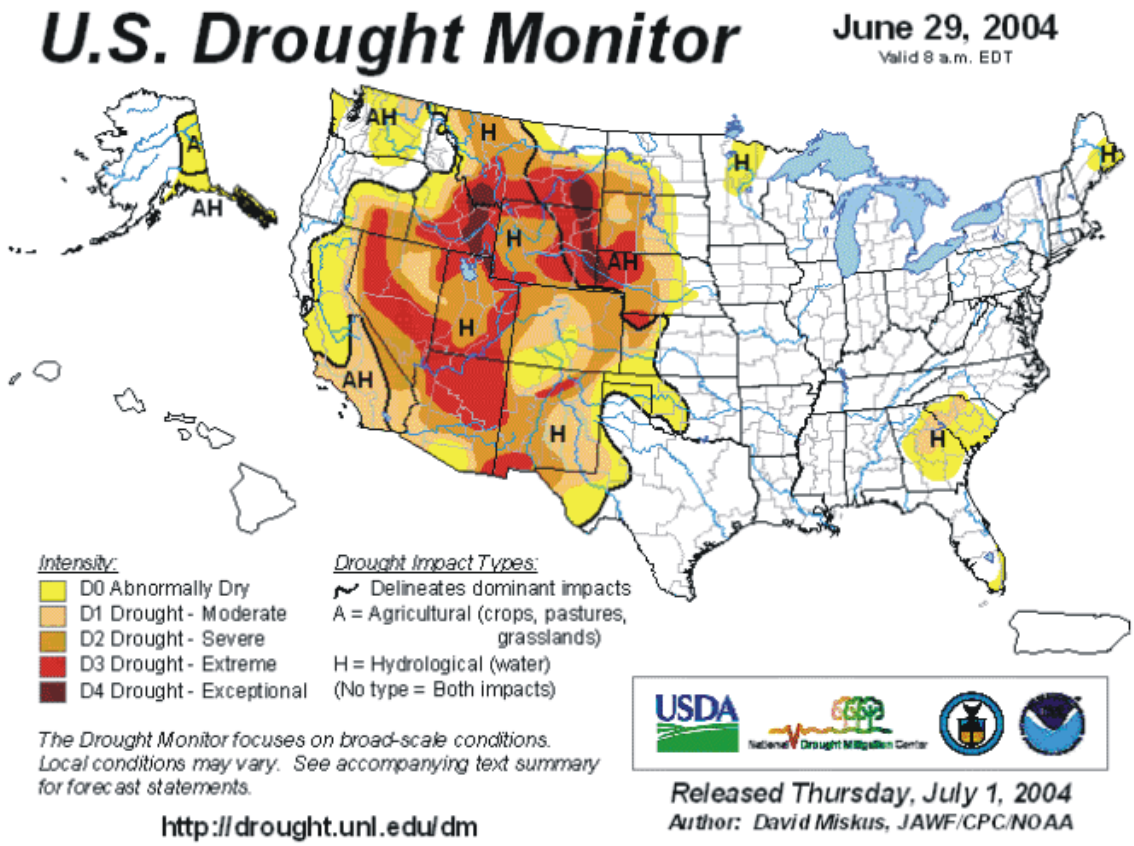

Figure 11 U.S. Drought Monitor depicts abnormally dry conditions experienced earlier this year across southwestern North Carolina have been elievated by significant June rainfall.

NC Weather Review Team

Phillip Badgett
Jonathan Blaes